GEOLOGICAL NOTES ON THE VICINITY OF BANFF, ALBERTA.

BANFF, the easternmost of the resorts established by the Canadian Pacific Railroad in the mountains of the Northwest, lies a little east of the axis of the Rocky Mountain range, on the Bow River, at an altitude of 4,521 feet. The surrounding mountains rise to heights of 8,000 to 10,000 feet and upward.

Structure of the mountains.—The Rocky Mountains in Alberta contrast with the same range in the United States in that folding and overthrust faulting are their predominant features. Their structure closely resembles that of the southern Appalachians, contrasting strongly with the Basin type where normal faulting is the rule.

In Alberta parallel ridges of folded Carbonic limestones are the prevailing features. These are underlain by Cambrian sandstones, and overlain by coal-bearing Cretaceous sandstones. About Banff the general trend of the ridges is northwest-southeast.

Drainage.—The normal drainage of the region is similar to that often noted in the Appalachian region; the channels being established either along the strike of some soft layer, or cutting across the ridges at right angles to the strike. In such a region stream robbery is common, and one river will, at an advanced stage of adjustment, present a series of right-angled turns, wind-gaps often indicating former channels.

Glaciation.—The Canadian Rockies have been heavily glaciated at a comparatively recent date. The glacial action appears to have been that of very large valley glaciers, rather than of the continental ice-sheet. Local moraines are common, and the larger valleys are bordered by glacial terraces.

The drainage in the vicinity of Banff presents several interesting features. The Bow River, after flowing southwest along the strike of the Cambrian sandstones, turns abruptly northeast, cutting a gap in the Sawback, Vermilion, and Cascade ranges (see map, Fig. 1). It then turns southeast again, flowing along the strike of a Cretaceous

FIG. 1.—Topographic map of the Rocky Mountains near Banff. Reduced from Canadian Geological Survey.

infold. At Banff the Bow River is joined by the Spray River from the southeast and by the Cascade River from the northwest. Lake Minnewauka outlets westward into the Cascade River, its eastern end leading through a wind-gap to the Ghost River.

The Bow Valley about Banff is drift-filled. Westward from the station its course is through gravel, largely stratified (Fig. 2). At the

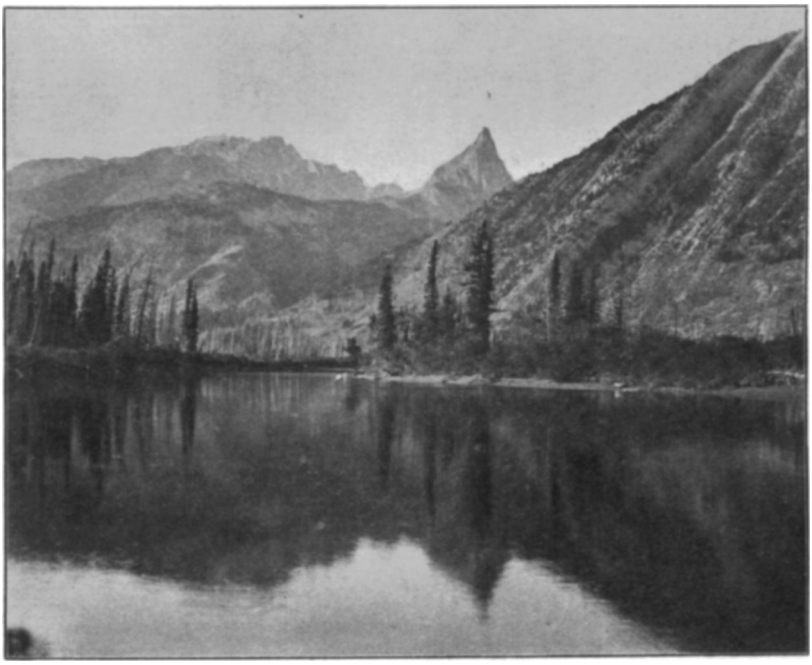

FIG. 2.—Still waters and alluvial deposits of the Upper Bow River above Banff; Mount Edith in the distance.

station the river turns abruptly southeast, cutting a little canyon along the strike of Carbonic shale and forming the Bow Falls. At its junction with the Spray it again enters drift and again turns northeast. There is here presented the abnormal feature of a water-fall along the strike, followed by quiet water when the course is at right angles to strike and up dip.

Forty-mile Creek flows southeast along the strike between Vermilion and Sawback ranges. It cuts across a gap in Vermilion

range and cuts off the end of Cascade Mountain. As it enters the Bow Valley it turns abruptly west, flowing over drift for a mile and a half, and emptying into Vermilion Lake.

These various abnormalities are the result of two distinct causes: first, adjustment to the soft Cretaceous infold of the lower Bow Valley; second, glaciation.

FIG. 3.—Devil's Canyon; a postglacial gorge of the Cascade River.

Lake Minnewauka (Devil's Lake) is a body of water twelve miles long and about half a mile wide. Its sides are precipitous, except close to the water's edge where glacial gravels are found. Alluvial cones occur, projecting into the lake. As noted by Dawson in 1885,[1] this lake basin presents every appearance of having formerly been a river valley. Its eastern end is now filled with drift, talus, and alluvial cones, but its level floor and steep sides extend to Ghost River on the east. Dawson, in the report cited, suggests that this was the

[1] *Report B*, Geological Survey of Canada, 1885, p. 141.

preglacial course of the Bow River. If this were the case, a drift-dam, or indications of an ice-dam, should be found, and the valley beneath the drift should present older features in the preglacial than in the present Bow Valley.

An investigation of the western end of the Lake Minnewauka disclosed hills of morainic aspect, evidently deposited at the junction of an ice-lobe descending the Cascade Valley with one coming from the Minnewauka Valley. Westward from these morainic hills is an overwash plain which descends westward and southeastward to form the upper terrace of the Cascade River. Lake Minnewauka is held up by this moraine, and its existence as a lake undoubtedly dates from the time of retreat of the ice. But that this dam could have diverted the Bow River is not possible. The outlet of Lake Minnewauka flows through drift for about a mile; it then joins the Cascade River, and together they flow through a postglacial gorge cut in Carbonic limestone. This gorge is known as the Devil's Canyon. The surface of this limestone is drift-covered, and the top of the gorge undoubtedly represents the height of the valley floor before the ice-invasion, also the amount eroded by the ice. This level is 5,000 feet. The limestone cut by the Devil's Canyon extends in a low ridge for more than a mile and blocks any considerable outlet or inlet of the Minnewauka Valley. Any river flowing in or out of this valley in preglacial times must have had its floor above 5,000 feet.

Five miles southwest of the lake the Bow River flows mainly over gravel. The Cretaceous beds are occasionally exposed, but the valley bottom is mainly in drift. The valley floor at this point is 4,350 feet, and the preglacial river in this valley could not have been higher. It therefore follows that no preglacial river could have flowed from the Bow to Lake Minnewauka Valley.

Moreover the lower Bow Valley (below the junction with Cascade River) is older physiographically than the Lake Minnewauka Valley. The sides are less precipitous, the cross-section, though steep sided, more nearly U-shaped.

In the opinion of the writer, the present drainage at this point is due, not to glacial agencies alone, but to preglacial adjustment to the soft Cretaceous beds. The Minnewauka Valley and the Bow Valley above the junction with Cascade River were probably once

one valley. Stream robbery then took place, owing to the advantage possessed by the present lower course of the Bow, a stream on the Cretaceous beds, over the upper part, the upper Bow-Minnewauka River. This adjustment was preglacial. The Bow was thus drawn away into its southeastward course in preglacial time, and a divide was established at the western end of Minnewauka Valley. A river

FIG. 4.—Bow Valley, from the Banff Springs Hotel; the preglacial course of the Spray River. At the left the Bow is emerging from its postglacial canyon.

continued to occupy this valley, emptying into Ghost River, until obliterated by the ice-invasion. The basin may have been deepened by ice-gouging; at all events, as the ice retreated northward, a lake was formed at its western margin, and an outlet was formed to the west, the eastern end of the gorge being still ice-filled. By the time the ice had retreated altogether, the westward outlet was too well established for a return to the eastward drainage. The present level of the lake is lower than that of Ghost River.

The abnormalities in the vicinity of Banff village appear to be due to glacial agencies only. Forty-mile Creek takes its abrupt westward bend at the point where its old valley is filled by drift. The Bow takes its southward turn around Tunnel Mountain for the same reason, namely, damming of its old valley by drift, its present rapids and fall being postglacial. South of Tunnel Mountain the Bow leaves its gorge and turns into the preglacial valley of the Spray (Fig. 4). The Spray itself has been pushed out of its valley at this point by talus from Mount Rundle.

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